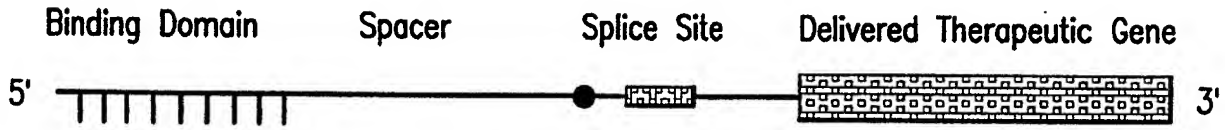

Binding Domain
Spacer
Splice Site
Delivered Therapeutic Gene
5'
3'

FIG.1A

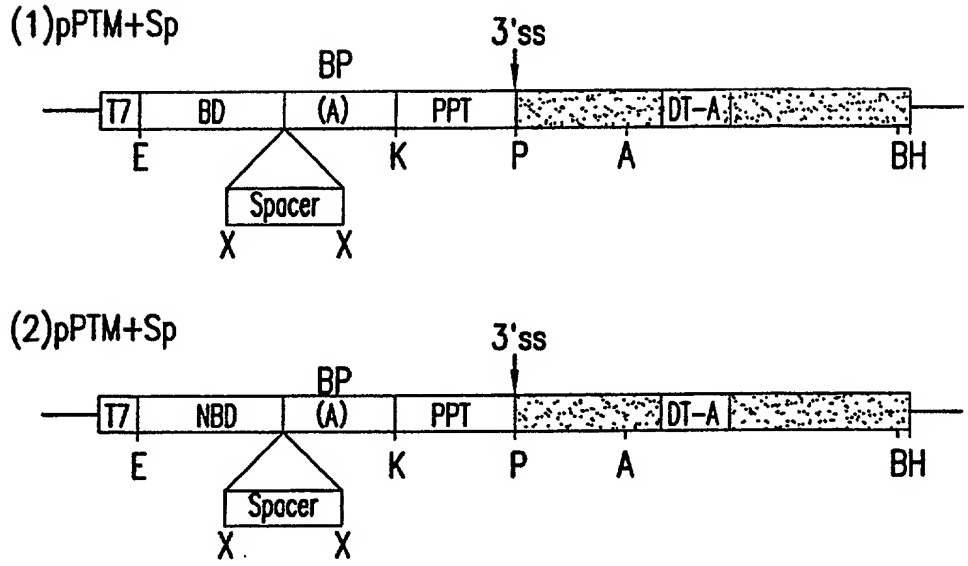

(1)pPTM+Sp
3'ss
BP
T7
BD
(A)
PPT
DT-A
E
K
P
A
BH
Spacer
X
X
(2)pPTM+Sp
3'ss
BP
T7
NBD
(A)
PPT
DT-A
E
K
P
A
BH
Spacer
X
X

FIG.1B

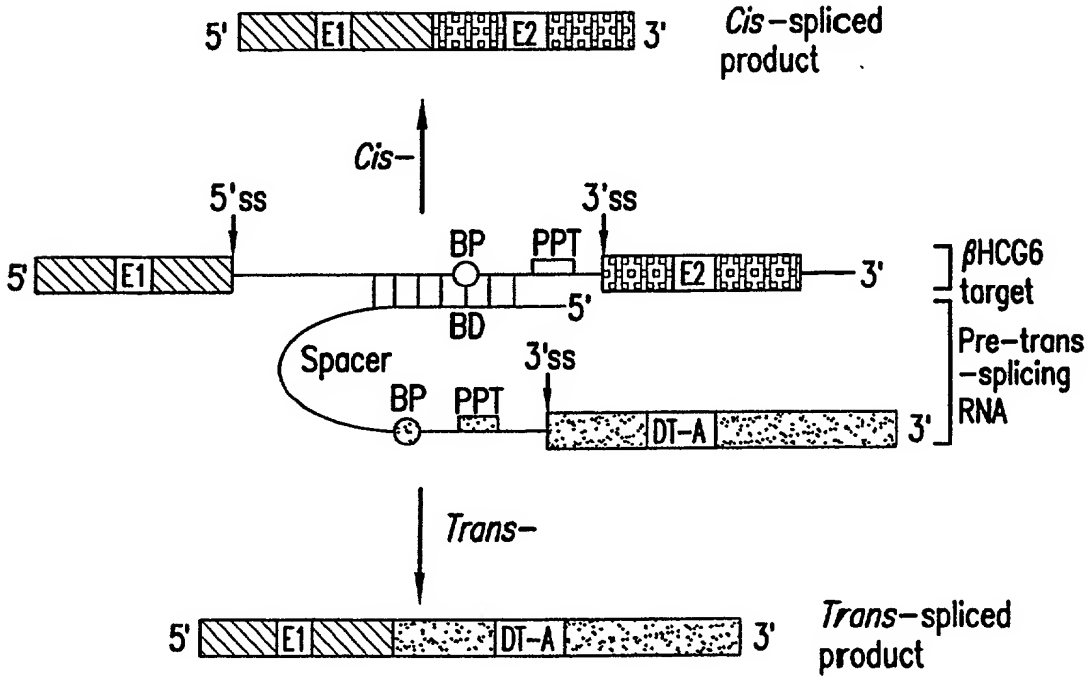

5'
E1
E2
3'
Cis-spliced product
Cis-
5'ss
3'ss
BP
PPT
5'
E1
E2
3'
βHCG6 target
BD
5'
Spacer
3'ss
BP
PPT
DT-A
3'
Pre-trans -splicing RNA
Trans-
5'
E1
DT-A
3'
Trans-spliced product

FIG.1C

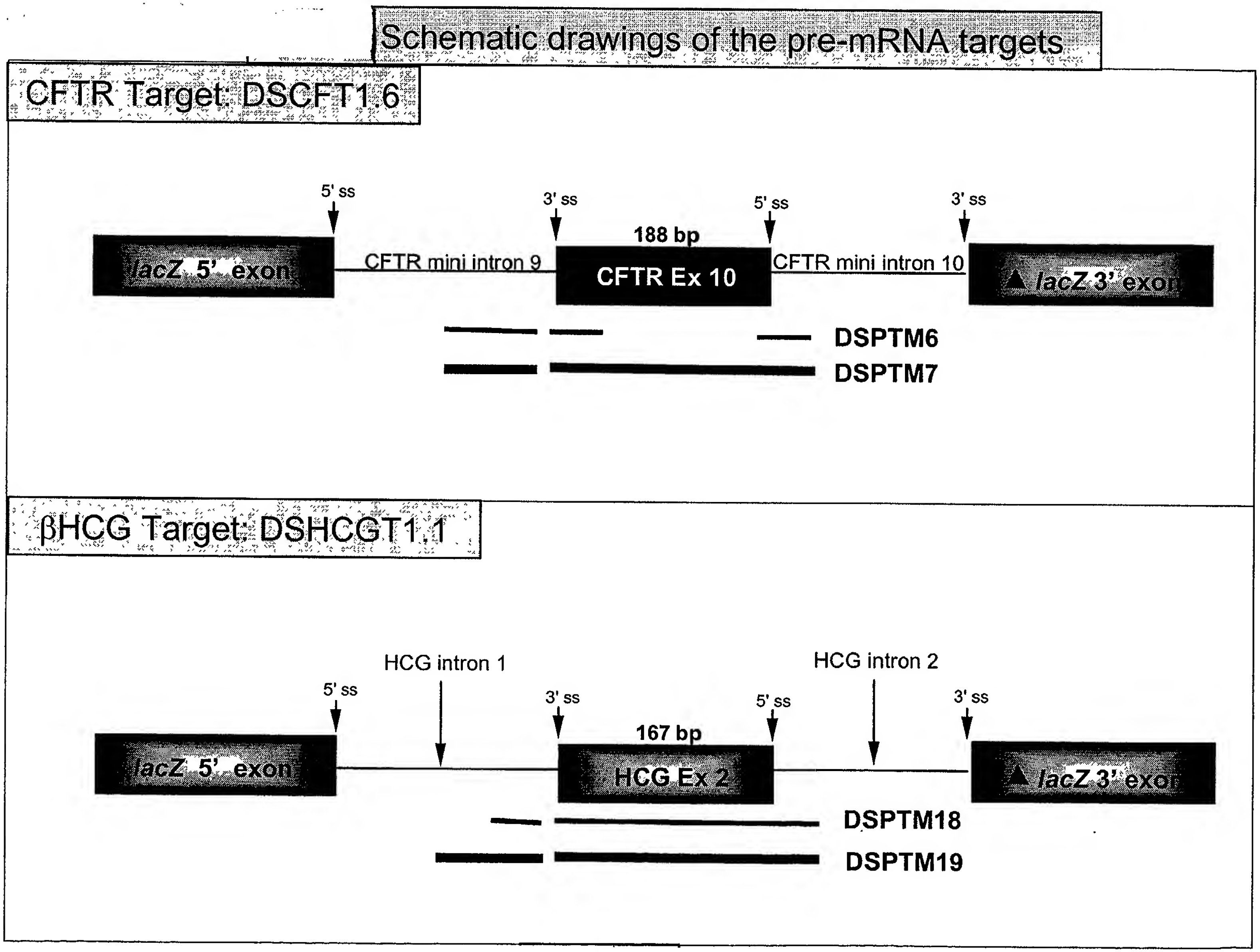

Schematic drawings of the pre-mRNA targets
CFTR Target: DSCFT1.6
5' ss
3' ss
188 bp
5' ss
3' ss
lacZ 5' exon
CFTR mini intron 9
CFTR Ex 10
CFTR mini intron 10
lacZ 3' exon
DSPTM6
DSPTM7
βHCG Target: DSHCGT1.1
HCG intron 1
HCG intron 2
5' ss
3' ss
167 bp
5' ss
3' ss
lacZ 5' exon
HCG Ex 2
lacZ 3' exon
DSPTM18
DSPTM19

Figure 2

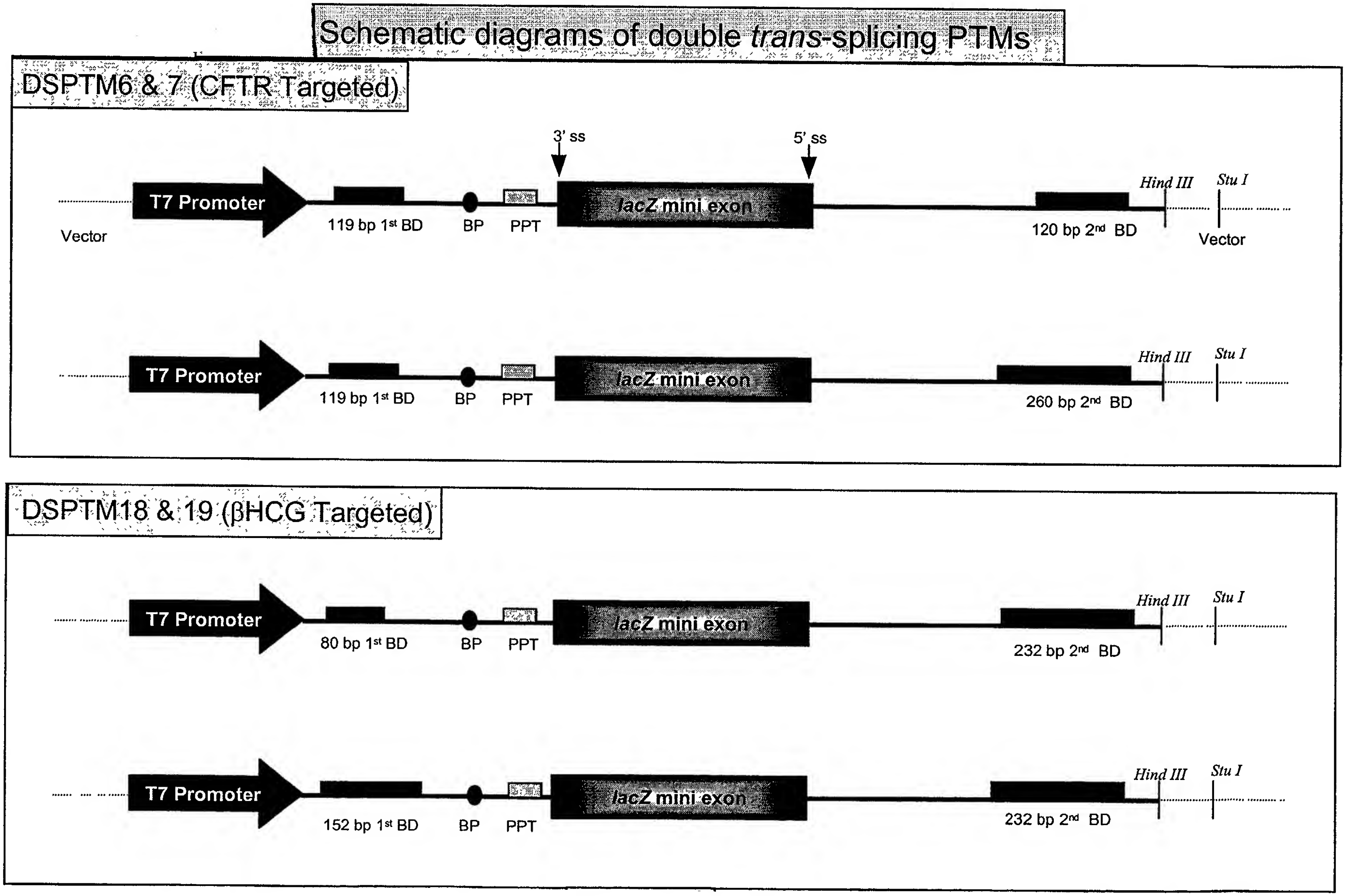
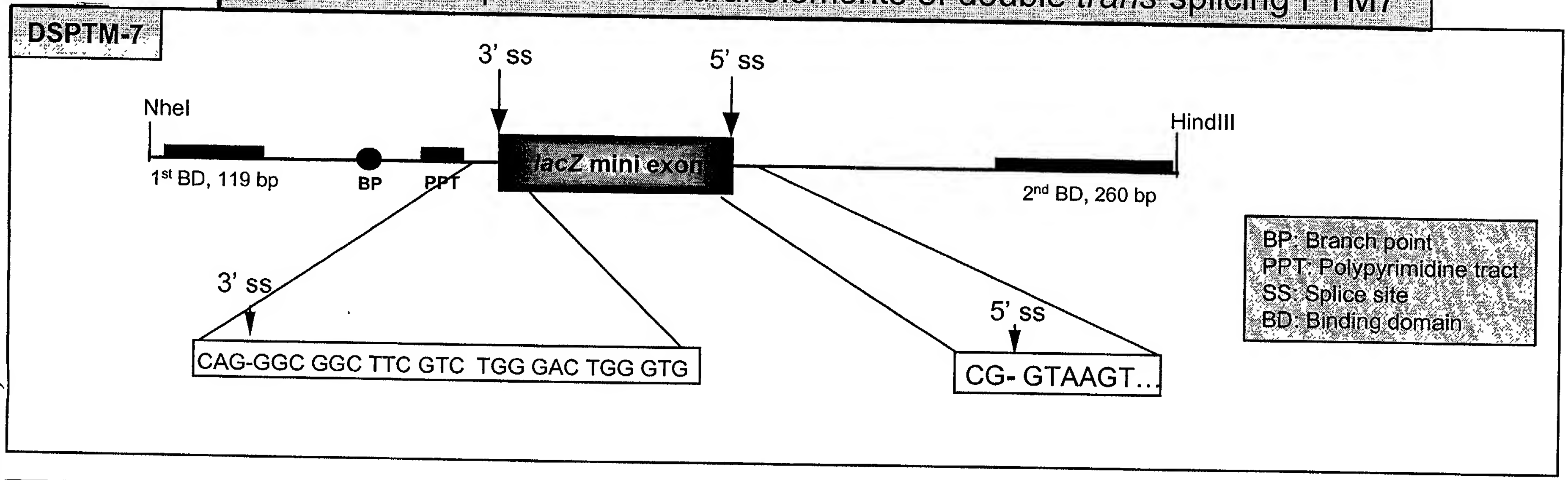

Schematic diagrams of double *trans*-splicing PTMs
DSPTM6 & 7 (CFTR Targeted)
3' ss
5' ss
T7 Promoter
119 bp 1st BD
BP
PPT
lacZ mini exon
120 bp 2nd BD
Hind III
Stu I
Vector
Vector
T7 Promoter
119 bp 1st BD
BP
PPT
lacZ mini exon
260 bp 2nd BD
Hind III
Stu I
DSPTM18 & 19 (βHCG Targeted)
T7 Promoter
80 bp 1st BD
BP
PPT
lacZ mini exon
232 bp 2nd BD
Hind III
Stu I
T7 Promoter
152 bp 1st BD
BP
PPT
lacZ mini exon
232 bp 2nd BD
Hind III
Stu I

Figure 3

Diagram and important structural elements of double *trans*-splicing PTM7



1st BD (119 bp) : GATTCACTTGCTCCAATTATCATCCTAAGCAGAAGTGTATATTCTTATTTGTAAAGATTCTATTAACTCATTTGATTCAAAATA TTTAAAATACTTCCTGTTTCATACTCTGCTATGCAC

Spacer sequences: AACATTATTATAACGTTGCTCGAA

BP / PPT / 3' ss / *lacZ* mini exon

BP, PPT and acceptor splice site: TACTAAC T *GGTACC* TCTTCTTTTTTTTTTT *GATATC* CTGCAG GGC GGC TTC GTC TGG GAC TGG

lacZ mini exon / 5' ss

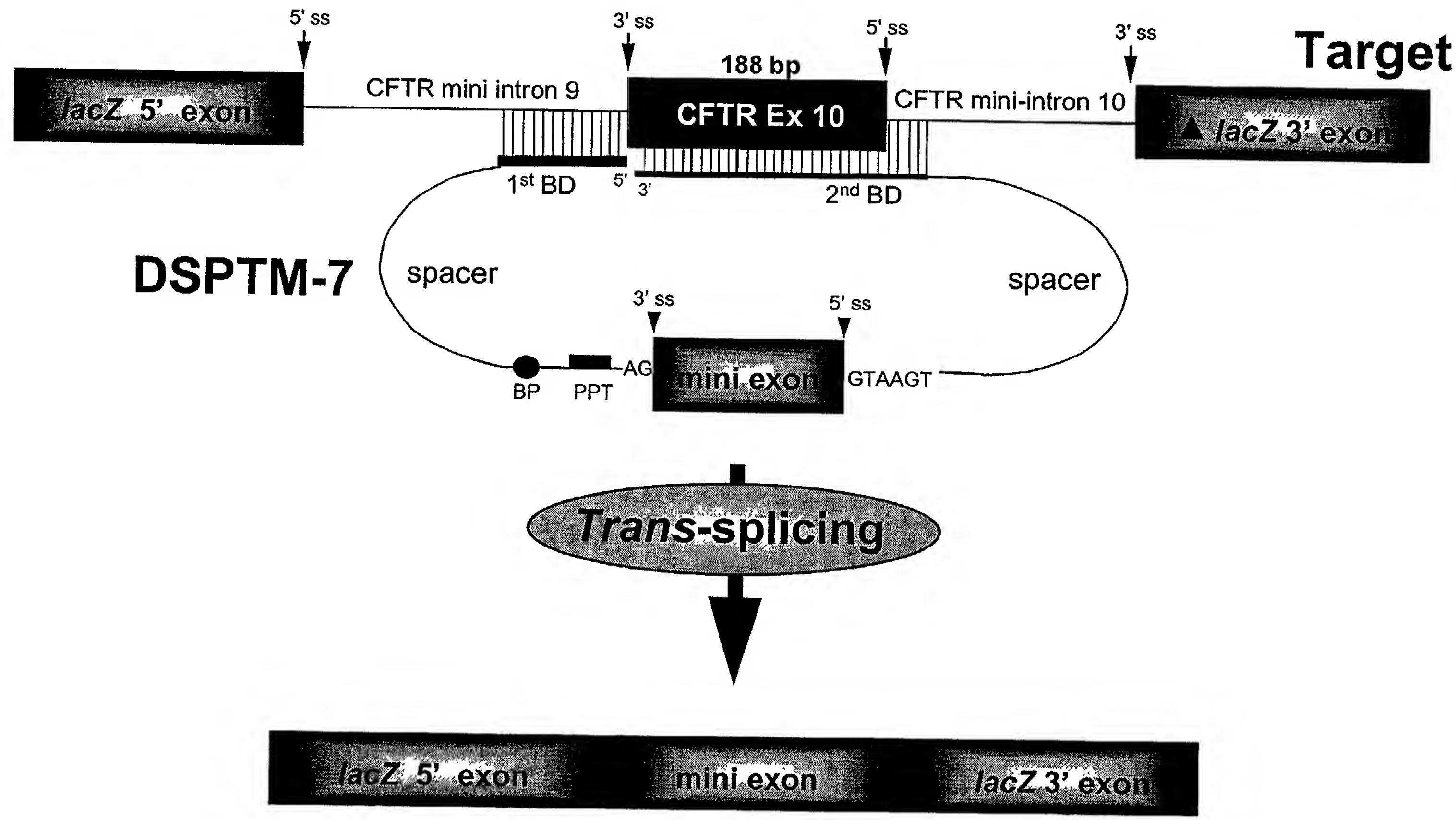
5' donor site and 2nd spacer sequence: TGA ACG *GTAAGT* GTTATCACCGATATGTGTCTAACCTGATTCGGGCCTTCGATACGCTAA GATCCACCGG

2nd BD (260 bp): TCAAAAAGTTTTCACATAATTTCTTACCTCTTCTT*GAATTC*ATGCTTTGATGACGCTTCTGTATCTATATTCATCATTGGAA ACACCAATGATTTTTCTTTAATGGTGCCTGGCATAATCCTGGAAAACTGATAACACAATGAAATTCTTCCACTGTGCTTAA AAAAACCCTCT*GAATTC*TCCATTTCTCCCATAATCATCATTACAACTGAACTCTGGAAATAAAACCCATCATTATTAACTCA TTATCAAATCACGC

Figure 4

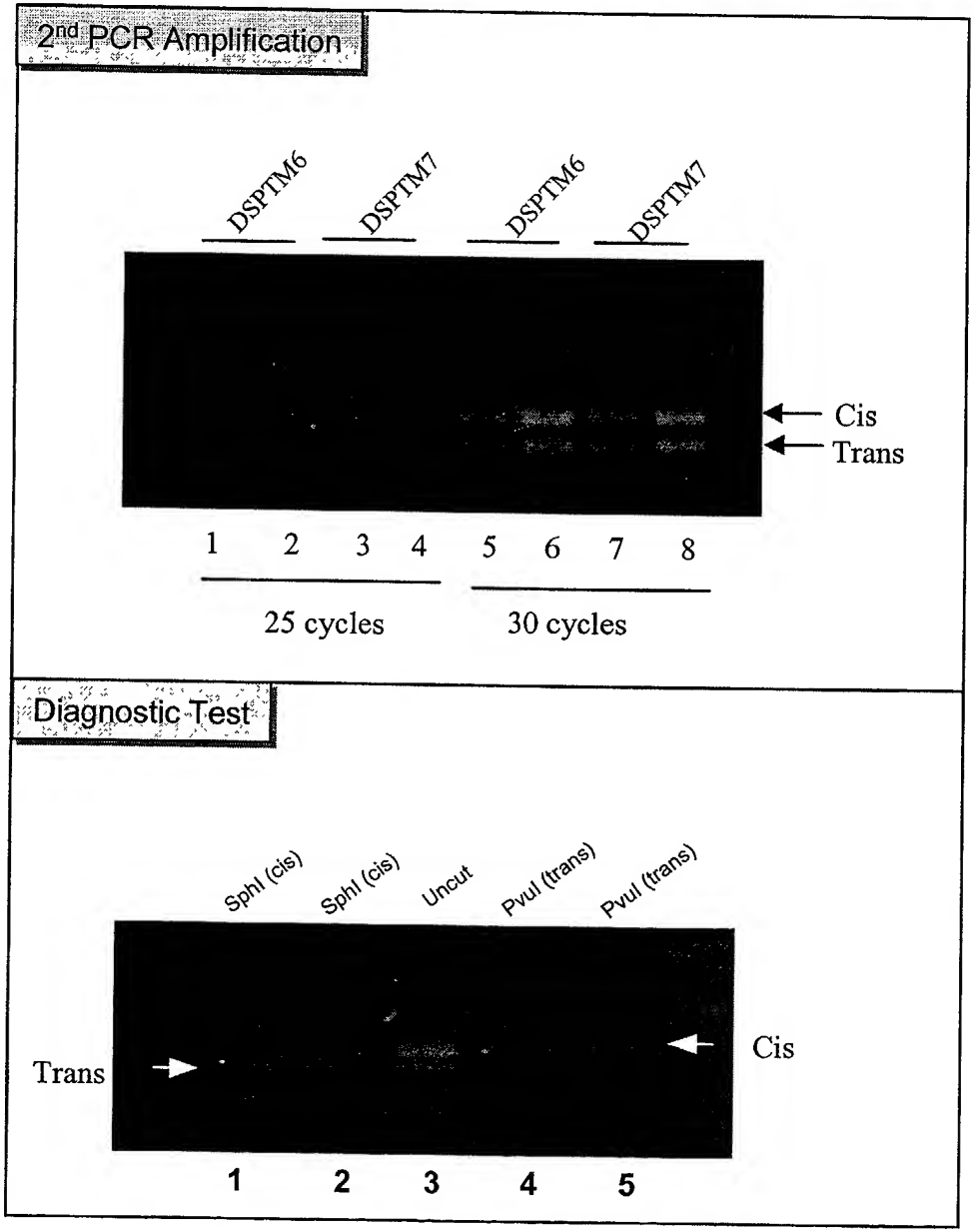
Figure 5

Double *trans*-splicing β-gal repair model



Accurate double *trans*-splicing between the target pre-mRNA and synthetic PTM RNA will result in the production of repaired *lacZ* mRNA

Proof-of-principle of SMaRT using synthetic double splicing PTM RNA in 293T cells



DSPTM6 and 7 (CFTR targeted)

Methods

Transfect 293T cells with DSPTM6 and DSPTM7 *in vitro* transcribed, gel purified RNA (2.5-5.0 μg)

Isolate total RNA, cDNA synthesis (Lac6R), PCR amplification (20 cycls, KI-1F + Lac6R), digest with *Sph* I + *Dde* I (*cis*-specific) at 37°C/ON

Purify double *trans*-spliced product using Biotin-Lac21R probe

PCR amplify the captured *trans*-spliced product (KI-2F+Lac6R). Expected products: *cis*- 260bp; *trans*- 220 bp.

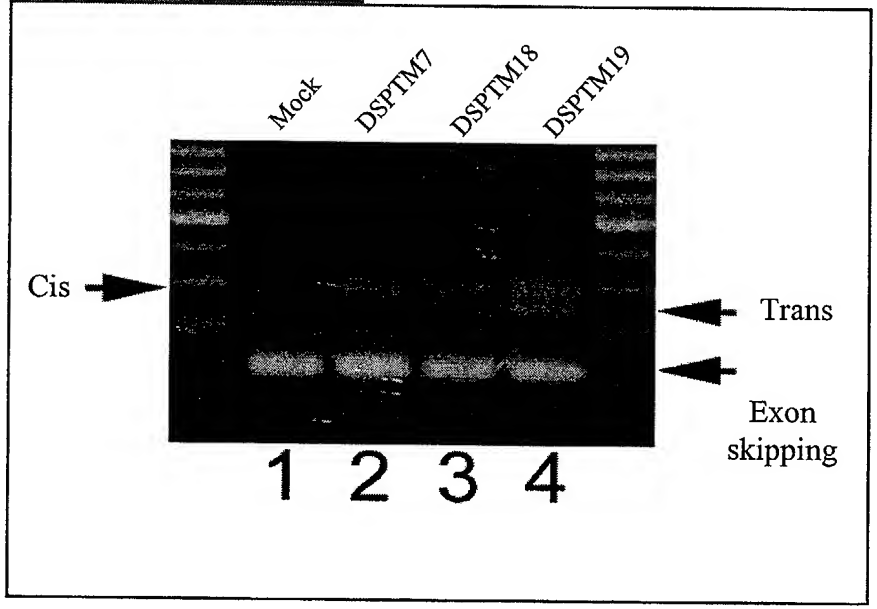
Diagnostic test: Digest PCR product with *Pvu* I (*trans*-specific) and with *Sph* I (*cis*-specific) at 37°C for 2-3 hr

Sequence to confirm the accuracy of double *trans*-splicing

Figure 6A

Proof-of-principle of SMaRT using synthetic double splicing PTM RNA in stable cells

2nd PCR Amplification



DSPTM18 and 19 (HCG targeted)

Methods

Transfect DSHCGT1.1 stable cells with DSPTM7, DSPTM18 and DSPTM19 *in vitro* transcribed, gel purified RNA (2.5-5.0 μg)

Isolate total RNA, cDNA synthesis (Lac6R), PCR amplification (20 cycls, KI-1F + Lac6R), digest with *Sph* I + *Dde* I (*cis*-specific) at 37°C/ON

Purify double *trans*-spliced product using Biotin-Lac21R probe

PCR amplify the captured *trans*-spliced product (KI-2F + Lac6R). Expected products: *cis*- 260bp; *trans*- 220 bp

Sequence to confirm the accuracy of double *trans*-splicing

Figure 6B

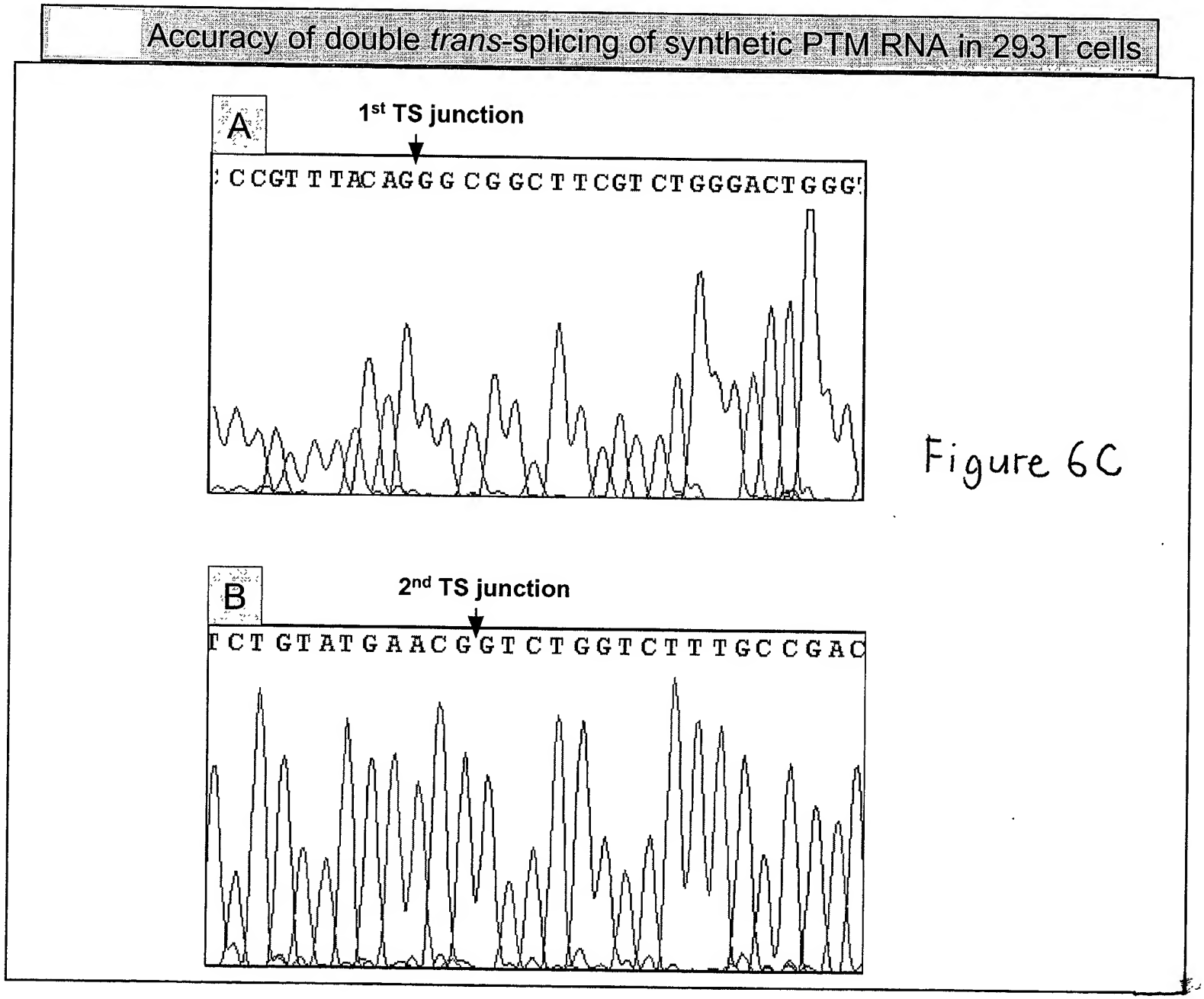
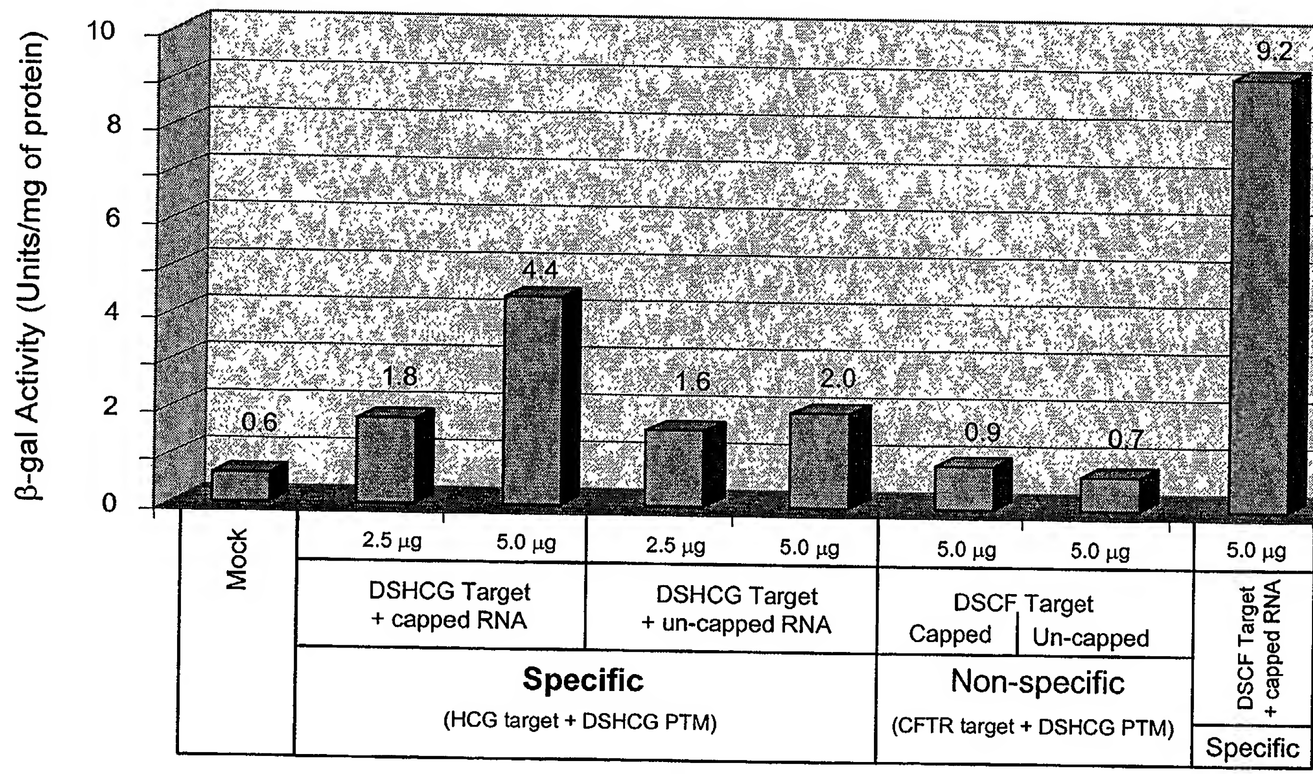

Accuracy of double *trans*-splicing of synthetic PTM RNA in 293T cells
A
1st TS junction
C C G T T T A C A G G G C G G C T T C G T C T G G G A C T G G G
B
2nd TS junction
T C T G T A T G A A C G G T C T G G T C T T T G C C G A C

Figure 6C

Restoration of β-gal function through RNA transfection in 293T cells
(Proof-of-concept for SMaRT RNA Therapeutics!!)
Synthetic RNA, Double *trans*-splicing



Methods

Transfect 293T cells
↓
Harvest cells after 48 hr
↓
Prepare cellular extract
↓
Assay for β-gal activity

Figure 7